

# Quantifying and Maximizing Performance of a Human-Centric Robot under Precision, Safety, and Robot Specification Constraints

Completed Technology Project (2015 - 2020)



## Project Introduction

The research project is an effort towards achieving 99.99% safety of mobile robots working alongside humans while matching the precision performance of industrial manipulators. These robots can be especially useful in multiple industries not limited to space applications. This proposal is aimed towards NASA's Technology Area Breakdown (TAB) TA 4.3.1 Robot Arms. The current issue is that have high precision industrial robots that are unsafe to work with humans. To make them safe under collisions, we can maneuver the industrial robot slowly but this decreases performance. If we want to move faster, we can use compliant robots or force control robots to obtain safe humanoid behaviors in collision, but we lose precision and the high performance that makes industrial robots so productive. My objective is to achieve the high precision performance of an industrial-grade robot with the safety capabilities of human-interacting compliant robots. I will accomplish this objective by (1) focusing on sensing processing for ultrafast collision detection, (2) analyzing the speed of response factoring actuator response times and latencies, (3) using high-stiffness control to move away as quickly as possible, (4) investigating non-linear materials that enhance signal processing and also dampen collisions, (5) comparing it with compliant robots in terms of speed response to safety, (6) building a new mobile industrial robot with safe-centered mechanical design to conduct 1,2,3,4,5 and (6) reporting the findings in highly prestigious journals. Developing a dexterous, high-performing, safe humanoid robot has many positive benefits for space applications. For example, current satellites and space stations can deploy these robots as avatars for astronauts to perform external repair work in a hazardous environment. This is inline with the goals of NASA's Robonaut, but an even more appealing application is the ability of humanoid robots to work side-by-side with current astronauts. These robots can perform menial tasks such as repeatedly mounting screws or hold tools and parts while astronauts work on more complex and mentally engaging tasks. If collaboration that involves direct or indirect contact with the robot is needed, it is necessary that the robot operates with the maximum allowable performance under safety constraints. These high-performing humanoid robots have the potential to act as helpers in building instrumentation and habitats for space exploration or conducting missions in other planets.

## Anticipated Benefits

Developing a dexterous, high-performing, safe humanoid robot has many positive benefits for space applications. For example, current satellites and space stations can deploy these robots as avatars for astronauts to perform external repair work in a hazardous environment. This is inline with the goals of NASA's Robonaut, but an even more appealing application is the ability of humanoid robots to work side-by-side with current astronauts. These robots can perform menial tasks such as repeatedly mounting screws or hold tools and parts while astronauts work on more complex and mentally engaging



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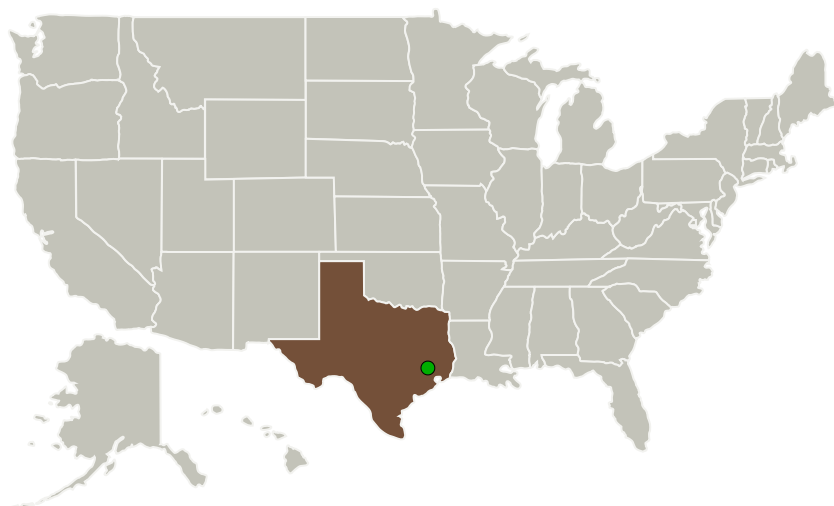
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## Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
The University of Texas at Austin	Lead Organization	Academia	Austin, Texas
● Johnson Space Center(JSC)	Supporting Organization	NASA Center	Houston, Texas

## Primary U.S. Work Locations

Texas

## Project Website:

<https://www.nasa.gov/strg#.VQb6T0jJzyE>

## Organizational Responsibility

### Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

### Lead Organization:

The University of Texas at Austin

### Responsible Program:

Space Technology Research Grants

## Project Management

### Program Director:

Claudia M Meyer

### Program Manager:

Hung D Nguyen

### Principal Investigator:

Luis Sentis

### Co-Investigator:

Steven Jens M Jorgensen

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## Technology Maturity (TRL)

Start: **2**  
Current: **2**  
Estimated End: **3**



## Technology Areas

### Primary:

- TX10 Autonomous Systems
  - └ TX10.2 Reasoning and Acting
    - └ TX10.2.4 Execution and Control

## Target Destinations

Earth, Outside the Solar System